Appendix 2

Author's review of her research achievements and publications

1. Name and surname

Katarzyna Wojczulanis-Jakubas

2. Possessed diplomas, scientific / artistic degrees - with the name, place and year of receiving

M.Sc. – University of Gdańsk, Faculty of Biology, Geography and Oceanology. Field of the study: biology. Specialty: Environmental biology, 2003.

Ph. D. – University of Gdańsk, Faculty of Biology, Geography and Oceanology. Field of the study: Biology. Speciality: Biology , 2007.

3. Information on previous employment in scientific / artistic institutions

University of Gdańsk, Faculty of Biology, Department of Vertebrate Ecology and Zoology
2007 - the present moment – assistant professor

4. Indication of achievement resulting from Article16 Paragraph 2 of the Act of 14 March 2003 on Academic Degrees and Title and on Degrees and Title in the Field of Art:

The achievement was to investigate **life-time strategies of males and females in a seabird, the little auk (*Alle alle*).** The achievement was documented as subject-specific paper series [1-7]. Coauthors' statements are contained in the Appendix 4.

a) (author / authors, title / titles of publications, year of publication, publisher name), notification about the scientific input into the publications, and bibliometric indices

[1] Wojczulanis-Jakubas K., Jakubas D. 2012. **When and why does my mother leave me? The question of brood desertion in the dovekie.** The Auk 129: 632-637, [IF = 2.404]
My contribution into this study combined: development of the concept of the study, fieldwork, labwork – molecular sexing, statistical analyses, manuscript writing, including results interpretations. I estimate my overall contribution into the paper on 85%.

[2] Jakubas D., Wojczulanis-Jakubas K. 2013. **Rates and consequences of relaying in little auks *Alle alle* breeding in the High Arctic – an experimental study with egg removal.** Journal of Avian Biology 44: 62–68, [IF = 2.235]
My contribution into this study combined: development the concept of the study, fieldwork, comments on the manuscript and editing. I estimate my overall contribution into the paper on 40%.

[3] Wojczulanis-Jakubas K., Jakubas D., Kidawa D., Kośmicka A. 2012. **Is the transition from biparental to male-only care in a monogamous seabird related to changes in body mass and stress level?** Journal of Ornithology 153: 793-800, [IF = 1.632]
My contribution into this study combined: development the concept of the study, fieldwork, labwork – molecular sexing, statistical analyses, manuscript writing, including results interpretations. I estimate my overall contribution into the paper on 75%.

[4] Wojczulanis-Jakubas K., Jakubas D., Kulaszewicz I., Kidawa D., Taylor J.R.E. 2014. ***Influence of primary reproductive investments on blood chemistry, leukocyte profile, and body mass in a small Arctic seabird.*** The Auk 131, DOI: 10.1642/AUK-14-62.1, [IF 2013 = 2.627]
My contribution into this study combined: development the concept of the study, fieldwork during the mating and incubation period, labwork – molecular sexing of the material collected during the mating and incubation period, statistical analyses, manuscript writing, including results interpretations. I estimate my overall contribution into the paper on 66%.

[5] Wojczulanis-Jakubas K., Jakubas D., Chastel O. 2013. ***Different tactics, one goal: initial reproductive investments of males and females in a small Arctic seabird.*** Behavioural Ecology and Sociobiology 68: 1521-1530, [IF = 3.049]
My contribution into this study combined: development the concept of the study, fieldwork, labwork – molecular sexing, statistical analyses, manuscript writing, including results interpretations. I estimate my overall contribution into the paper on 74%.

[6] Wojczulanis-Jakubas K., Jakubas D., Chastel O. 2013. **Behavioural and hormonal stress responses during chick rearing period do not predict brood desertion by female in a small Arctic seabird.** Hormones and Behavior 64: 448-453, [IF = 4.511]
My contribution into this study combined: development the concept of the study, fieldwork, labwork – molecular sexing, statistical analyses, manuscript writing, including results interpretations. I estimate my overall contribution into the paper on 72%.

[7] Wojczulanis-Jakubas K., Dynowska M., Jakubas D. 2011. **Fungi prevalence in breeding pairs of a monogamous seabird – little auk, *Alle alle.*** Ethology Ecology & Evolution 23: 240–247, [IF = 0.743]
My contribution into this study combined: development the concept of the study, fieldwork, labwork – molecular sexing, statistical analyses, manuscript writing, including results interpretations. I estimate my overall contribution into the paper on 74%.

b) description of the scientific aim of the study and results obtained with description of their potential application

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The subject-specific paper series describe life-time strategies of males and females in the little auk (*Alle alle*). This is a colonially breeding seabird, with breeding distribution restricted exclusively to islands and archipelagos of the High Arctic zone, i.e. Greenland, Svalbard, Jan Mayen, Franz Jozef Land, Nowaya Zemlya, Severnaya Zemlya. Single, small populations are noted from islands on Pacific. The species is the most numerous alcid in the North Atlantic, and probably the most numerous seabird of the world (> 37 mln breeding pairs, reviewed P19).

Breeding in the Arctic constitutes an energetic challenge for the little auk. Incubation in the conditions of low ambient temperature needs to be uninterrupted, and that imposes time-constraints on incubating birds. Then, chick provisioning is even more time and energy consuming due to: a) foraging on distant foraging areas and/or in suboptimal density of the preferred food items (np. P26, P27, P32, P34, P36); b) body shape of the little auk – flying-diving compromise in the birds anatomy imposes high costs of the flight. For all that reasons, little auk brood size is restricted to a single chick raised annually. (Stempniewicz 2001). Even though, biparental care is needed to raise the offspring successfully. (np. Harding *et al.* 2004, P24).

Brood size reduction and the mode of biparental care are characteristic for all seabirds. (Schreiber & Burger 2001). The trait that is unique for seabirds, but typical for the little auk is the female brood desertion at the end of the nesting period (Stempniewicz 2001). This female strategy is recorded only in few species of *Charadriiformes*, including *Alcidae*, and specifically *Alcini* tribe, which only four species belong to, i.e. the little auk, two guillemots (*Uria algae, U. lomvia*) and razorbill (*Alca torda*). In general, causality and mechanisms of brood desertion by avian females are poorly understood. In that context, the little auk represents an ideal model species for investigating such a female strategy.

Several hypotheses have been proposed to explain the reasons and mechanisms of the female brood desertion. Of that, the most frequently evoked one bases on the model of Maynard-Smith (1977). According to that model, brood desertion by one parent (here a female) increases its fitness through an additional offspring being produced in the second mating attempt, on condition that staying with the first brood does not increase the reproductive success. Two papers from the subject-specific series showed that this explanation of female brood desertion is not applicable to the little auk due to the timing of the female desertion. Paper [1] provides, for the first time ever, the timing of the female brood desertion, which is on average on 26 day of chick's life, so the very end of the nesting period. The end of the little auk nesting period coincides with the ending of the arctic summer, the period beyond which raising the offspring is not possible due to climate constraints. Results of the experimental study presented in the paper [2], show even better that a second reproductive attempt in the same season is unlikely to be successful. Birds that have been relaying in the given season, even they did within two weeks after the first egg being removed, had significantly lower breeding success compared to the control group.

Another reason of the female brood desertion may be that deserting female may be approaching a critical level of her body condition. Although little auk males and females seem to share parental care (incubation and chick rearing) equally (PhD thesis of Wojczulanis-Jakubas, [3]), the cost of the parental performance may be different for each sex due to the anatomical and physiological constraints. That hypothesis has been have verified in paper [3],

where changes in stress level and body mass in the two sexes were examined during the periods of parental care, i.e. incubation and chick rearing. Results of the study showed pronounced and similar for two sexes changes in stress level corresponding to the changes in parental efforts across the studied period. There were no changes in body mass of both males and females, although in general females were found to be significantly lighter than males. All that indicates that females deserting the brood at the end of chick rearing period are in relatively good physical shape. Their stress level is very similar to that of males, and body condition is at least as good as at the beginning of that period.

Nevertheless, lower body mass of females revealed in the paper [3] strongly suggests that females had been made greater reproductive investments than males. Although male and female parental performance at the stage of parental care is similar, initial reproductive investments may be female-biased. In fact, it is a common assumption that costs of gametes production is greater in females than males. That may be particularly true in the little auk, in which females produce relatively large egg (ca 20% of female body mass, Stempniewicz 2001). A cumulative effect of all reproductive costs, including egg production may affect the female body condition, and so make her prone to desert the brood at the end of the nesting period. That hypothesis have been verified in paper [4], were various haematological and biochemical parameters (never examined in the little auk before) in males and females were examined during the most crucial period, i.e. egg-laying. To fully comprehend the costs associated with egg production, the reproductive investments were experimentally increased by inducing females to relay the egg. Also, for the first time ever, the time needed for the production of the little auk egg and its real energetic value was investigated. The results showed that the process is relatively fast compared to other seabirds/alcids, with on average 5 days needed to produce a single egg. Energetic value of the egg, so the cost of its production turned out to be not as high as it has been assumed. The energy required could be obtained by female taking daily for five days a food being equivalent of two loads delivered to chick. Interestingly, pronounced but not sex-specific changes were found in the examined haematological and biochemical parameters corresponding to efforts associated with given reproductive events (egg laying, relaying, chick rearing). This lack of sex differences suggests that changes have a hormonal-based origin. Hormonal changes, although different in nature may be similar in two sexes during the mating period (females produce the eggs, males guard the site and mate [5]), and so the initial reproductive costs may be similar for males and females. Nevertheless, the results of the [4] study confirmed lower body mass of females compared to males revealed in paper [3]. Also, re-laid eggs were significantly lower than the first one ([2], [4]) what suggest the egg production is not so straightforward when conditions are somehow disadvantageous/disrupted. All that indicates that females may be more prone to body reserves depletion than males and that may be the reason for their earlier brood desertion.

Regardless of the reasons which for he little auk female abandon the brood, the male may stay with the offspring to minimize predation pressure during the fledgling period and the first days/weeks at the sea. Being a little bit larger and more aggressive than female, the male may be also bolder and so more predisposed for that kind of parental care. That hypothesis has been verified in the paper [6]. Using an experimental approach, behavioural and hormonal stress response of males and females were investigated. Any sex differences

neither in behaviour nor hormonal changes were found. That strongly indicates on similar male and female response to stressors, and so undermines the hypothesis about a male predisposition for performing the final parental duty.

The study [1] shows that little auk female deserts the brood when bi-parental care is not needed any more. An additional explanation of the male staying with the offspring while the female deserts, may be his nest-site guarding. This seems to be supported by the sex difference in the time spent in the colony. Another paper from the subject-specific series showed that little auk males stay in the colony longer than females [5].

In paper [5] another life strategy trait was considered - the question of extra-pair mating. It is commonly believed that extra-pair mating can increase fitness of both sexes, although in different way for males and females (Petrie & Kempenaers 1998). For that reason, extra-pair contacts are frequent even in socially monogamous species. While parent female is usually related to the offspring she takes care for no matter of occurrence of extra pair contacts, this may not necessarily be the case for males. Cuckolded male taking care for unrelated offspring apparently decreases his fitness. Therefore, the most advantageous male strategy should be guarding his paternity in own family with simultaneous trying to gain an extra-pair offspring. This generates a natural conflict of males and females interests, and that may be particularly strong in a colonially breeding species (proximity of many potential sexual partners). It has been already showed that extra-pair copulations are frequent in the little auk but extra-pair fertilization is rare (<2%, P10). Results of the [5] study showed that genetic monogamy in the little auk is maintained mainly due to females' rejecting behaviour. The males also try to guard their paternity, but these are females that control with whom they mate.

The most plausible explanation of female rejecting behaviour is necessity of male assurance about his parentage. The male aware of being cuckolded could refrain from engaging into costly parental care, and that could result in the lower breeding success of female, if any. This hypothesis is difficult to be tested but results of a study with experimental burden/removal of one parent strongly suggest, that bi-parental care is indeed necessary in the little auk to raise the offspring successfully (P28). An alternative or additional explanation of the female rejecting behaviour may be minimizing the risk of infection by sexually transmitted diseases. This interesting hypothesis has been tested by only few Authors, and for passerines only (e.g. Lombadro & Thorpe 2000, Hupton et al. 2003). Thus, in paper [7] this hypothesis was tested examining microfungi (yeast and moulds) in cloaca of the little auks. Quite high frequency of fungi infection (34% birds being positive) was found and all recorded species were potentially pathogenic. Given that fungi could be a risk factor in extra-pair contacts. However, composition of fungi assemblages in breeding members was not found to be concordant. That suggest that fungi transmission is not such straightforward as it has been assumed.

All studies mentioned above has been supported by grants, in which I was principal investigator (G11, G13, papers: [2], [3], [4], [5], [6]) or investigator (G7, papers: [1], [7]).

5. Description of other scientific-research achievements

a) Period before and during Ph D studies

I have started my research activity with M. Sc thesis titled „*Significance of the food regurgitated by the great cormorant Phalacrocorax carbo L. as the food resources for the grey heron Ardea cinera L. from the mixed colony in w Kąty Rybackie*" (in Polish), being supervised by prof. dr. hab. Lech Stempniewicz from Department of Vertebrate Ecology and Zoology at the University of Gdańsk. Result of the study showed that the fish regurgitated by the cormorants constitutes an important food resources for the local population of the grey heron, particularly at the stage of chick rearing and fledging. The study also revealed that usage of the regurgitated items is site-specific. Results of this study have been published in P), two years after closing the project.

Just after M. Sc defense, I have started PhD studies on Environmental PhD Studies of University of Gdańsk, and PhD project titled: „*Parental investments of males and females in a monogamous seabird (the little auk Alle alle) in the condition of polar day*", being supervised by prof. dr. hab. Lech Stempniewicz from Department of Vertebrate Ecology and Zoology at the University of Gdańsk. I examined the parental investments issue during particular stages of breeding (mating, incubation, chick rearing) in the little auk colony in Hornsund (Spitsbergen, Norway), during four field seasons (2003-2006). The studies were funded by grants G2 and G3. I used various methods to investigate parental efforts; that were: direct observation of birds behaviour (number of chick feedings, time spent in the colony, etc), analysis the amount and quality of food delivered to chick, analysis of the birds body condition (leukocyte profile, body mass). Due to negligible dimorphism in body size of the little auk (P4) I established the sex of birds with molecular tools. I have learnt molecular sexing (in fact, I use and develop it to present day) during training both in Poland (Dept. of Microbiology, University of Gdańsk, Museum and Institute of Zoology, Polish Academy of Science, Warsaw) and abroad (Natural History Museum, Oslo, Norway).

Based on the material collected during the PhD studies, I have published with co-authors five papers. Two of them – P3 and P4 have been published before PhD defense. In paper P4, we considered usage of biometrics in sexing the little auk. Since we found little auk males being significantly larger than females, we proposed a discrimination function that could be of use to tell the sex of birds based on their measurements. We recommended, however, that the function should be used with caution due to large overlap of the males and females body measurements, especially if randomly captured birds (not pair members) are considered. In paper P3 we showed that food delivered to chick by male and female parents differ in quality and quantity. This results was surprising as the little auk has very high metabolism rate (the highest recorded for seabirds so far, Gabrielsen *et al.* 1991). To cover such extreme energy demands the birds need to focus on very specific, energy-rich zooplankton items associated with arctic waters. In that context, one could expect a uniform diet delivered to chick regardless of the parent sex. Results of P4 showed, however, that foraging of males and females is much more complex.

The three papers published after PhD defense presented males and females behaviour during the mating (P10) and incubation period (P11), as well as body mass and stress level of the two sexes during the incubation (P6). As mentioned above, in part 4b we showed in P10 that extra-pair mating in the little auk is frequent but unsuccessful (low level of extra-pair paternity). This study provided a background for the further studies of reasons and

mechanisms of maintaining genetic monogamy in the little auk ([5], [7]). Comparing the birds behaviour during the incubation period in P11 we found that although pair members share the duty of egg warming equally, guarding the nest-site is male-biased. That labour division corresponds to differentiated stress level, with the increasing values in males and decreasing in females during the incubation period (P6).

Strong synchronization of timing of breeding, which is the case in the little auk, and exploitation of the little auk population by the glaucous gull (*Larus hyperboreus*) allowed me and co-authors to investigate the influence of the synchronization on predator-prey relationship in the paper P1. As similar in methodological approach study was performed in the same colony 20 years ago by one of the co-authors, we were also able to examine this relationship in a longer period of time. We found that, owing to the synchronization of the little auk phenology, predatory pressure is impaired, although greater compared to the period of 20 years ago.

b) Period after PhD studies

I performed my research after the PhD studies being focused on five topics. First topic was the life-time strategy of avian males and females, with the little auk as a case study. That part of my research activity constitutes a subject-specific series being the scientific achievement, and was described in the part 4b. The second topic was the response of planktivorous little auk to climate and oceanographic changes currently ongoing in the Arctic ecosystem. The third topic which I deal with was spatial differentiation of populations of colonially breeding seabirds. The activity within fourth topic comprised various issues associated with ecophysiology, morphology and migration with special emphasis on small passerines dwelling a reedbed habitat. Finally, the fifth topic was the brood sex ratio in the great cormorant, in regards to the birds phenology and spatial distribution of nests. I will describe each part separately below.

Response of planktivorous little auks on the ongoing climate and oceanographic conditions in the Arctic

I was employed in Dept. of Vertebrate Ecology and Zoology at the University of Gdańsk just after PhD defence and I was co-investigator in projects of prof. dr. hab. Lech Stempniewicz (G1, G4-G7) for four consecutive years. That allowed me to examine the issue of little auk response on climate and oceanographic changes, currently ongoing in the Arctic ecosystems. In the same time, I was preparing the publications described above in the part 5a (P6, P10, P11).

Foraging ecology and population abundance make the little auk a prime model species for investigating the changes in the marine and terrestrial ecosystems of the Arctic. Due to extraordinary energy demands of the little auk (Gabrielsen *et al.* 1991), majority of the birds diet is constituted of zooplankton associated with cold, arctic waters. This zooplankton is much more energy rich then its counterpart associated with warm, atlantic water masses. For that reasons, when an influx of warm, atlantic waters happens in the vicinity of the little auk colonies, birds should respond adequately – elongate foraging trips to find an appropriate

areas with cold water masses, or to increase the feeding frequency and/or duration of foraging when they forage in suboptimal conditions. I tested these hypotheses with interdisciplinary and international team in three little auk colonies on Spitsbergen (Hornsund, Magdalenefjorden and Isfjorden) that differ in oceanographic conditions (P18, P23, P32, P36, P43, P46). We also took advantage of the fact that we carried out the study for eleven consecutive years. That allowed us to look at the issue through interannual variation in the oceanographic conditions (P5, P16, P27). Although each of these studies investigated different aspects of the birds response to the climate changes, all are consistent in showing that birds increase their parental effort when the conditions are unfavourable. For instance, they increase the number of feedings trying to compensate a worse quality of food in the places and/or seasons with an influx of atlantic waters (P5). Increased duration of foraging trips revealed for example in paper P23, and high abundance of atlantic zooplankton items in diet revealed in P18 and P27 suggest that the birds forage in suboptimal conditions, when those are on their foraging areas nearby the colony. However, using a miniature GPS-loggers in the studies P26, P28, P34, P44 we found that in the condition of influx of warm water masses in the vicinity of the colony, little auks apply rather mixed strategy. They perform their trips both on the close (up to 60 km) and distant foraging areas (up to150 km from the colony). Variable distance and duration of the foraging trips is also associated with the bimodal foraging strategy, where parent birds alternate series of short trips which serves exclusively for chick provisioning with a longer trips, which in turn serve self-maintenance (P16, P44). Although breeding little auks apparently adjust the parental efforts to the foraging conditions, we did not found strong evidence that affect their body condition and stress level (P23, P36). However, we found that duration of the nesting period increased, and body mass of the chicks was lower in seasons and places with the influx of atlantic water masses, so the reproductive success of the birds breeding was lower compared to those breeding in more adventurous conditions.

Changes in the little auk phenology is another issue of the birds response to the ongoing climate changes in the Arctic. The timing of breeding in the little auk is strongly linked with the timing of snow melting in the colony. We investigated the issue both in micro and macro scale. In a micro-scale (P22), we found that different topography and exposition of colony patches resulted in different time of the snow melting, and that in turn affect the timing of breeding of the birds from given colony patches. In macro-scale (P12), examining the timing of breeding across 40 years, we found that little auks shifted the onset of breeding by one day per decade, and that is associated with the changes in the timing of snow melting in the colony. In the same paper P12, we also found significant relationship between climate parameters and timing of breeding in the kittiwakes *Rissa tridactyla*. Even few days difference may make a big difference in the conditions of the Arctic summer (match-mismatch hypothesis). Based on results obtained, we are preparing now another project which aims to further investigate how these phenological changes affect the birds reproductive performance.

Morphological and genetic differentiation of populations of colonially breeding seabirds

Apart from breeding biology and ecology, I have also dealt with population ecology. Studying that issue, I also focused on the little auk, as this is one of the keystone species of the Arctic and functioning of its populations (gene flow/ individuals exchange among the colonies) is unknown. I performed the study within the grants G9, and G12, which I was the leader of. I have collected material for the purpose of the study on my own or from collaborating colleagueas. In total, we have collected material that allowed to examine the global population. The project required specific laboratory (genotyping and sequencing) and analytical skills, which I gain during my visits in Natural History Museum in Oslo (Norway) and at the Queen's University in Kingston (Canada), as well as during the training organized by Polish Genetic Society in Sopot (Poland) and Museum and Institute of Zoology, Polish Academy of Science in Warsaw (Poland). Two papers have been published so far as the output of the project. The first one showed significant differentiation of the birds body size in the global population, with birds from Greenland being smaller than birds from Spitsbergen (nominative subspecies, *A. a. alle*), and the largest birds breeding on Franz Josef Land, and belonging to another subspecies (*Alle a. polaris*). We found that this morphological differences between the populations may be related with the climate conditions in the place of breeding (also possibly wintering), following ecological Bergmann's rule. However, investigating frequency of microsatellite alleles and mitochondrial haplotypes in P37, we did not found genetic structure corresponding to the morphological differentiation within the nominative subspecies. The only population that seemed to be a little bit different genetically from others (the highest frequency of private alleles) was the one located on Pacific, so the most distant from other colonies. Results of the study clearly suggest a strong gene flow between the little auk colonies, except for the most distant locations, which may be isolated at certain extent.

I continue the study on genetic differentiation of the little auk populations. Only recently, I have submitted to a journal (The Auk) another manuscript, in which I deal with co-authors with genetic differences between the two subspecies, as that issue was hardly investigated in P37 due to low sample size. We showed in this study that the two subspecies are as similar to each other as populations of the nominative subspecies, at least in neutral markers. The reason of this may be relatively recent divergence of the subspecies, estimated on 25000 years ago. The lack of genetic difference between the two subspecies is intriguing given the morphological differences. It cannot be excluded that neutral markers which have been used so far were not sufficient enough to indicate on difference between the groups isolated only recently. Therefore, I am currently working on coding regions of little auk DNA (genes of major histocompatibility region, MHC), which using may help to estimate more precisely the level of gene flow between the two subspecies.

I continue the research activity in the genetic differentiation of populations not only with the little auk. Quite recently, I have started the project on the genetic differentiation of populations of the great cormorant *Phalacrocorax carbo sinensis*, using funds from grant I was a leader of (G10). The project is carried out in cooperation with dr Robert Rutowski from Museum and Institute of Zoology, Polish Academy of Science in Warsaw (Poland), and people who deal with the cormorant ecology in Poland and abroad. Global populations of the great cormorant increased considerably. Such a big population of piscivorous, colonially breeding seabird brings on serious conflicts with fishermen and foresters, who perceive the

species as a rival and pest. Current management of the cormorant populations is focused on restriction of the population size. However this management activity is not efficient as it is done mainly by shooting the birds on fish ponds and roosts, without any knowledge about the way of population functioning (m.in. individuals exchange rate among the colonies, range of the migration, etc). The aim of the current project is to fulfil the gap in the knowledge, using molecular tools (sequencing of mitochondrial DNA, and genotyping with microsatellites). The project is still in progress, as new sets of samples, worth to include in the study are still collected. However, results obtained so far clearly indicates on strong gene flow between the colonies, which probably explain low efficiency of the population reduction by shooting some individuals from given colonies.

I also dealt with spatial differentiation of population of another seabird, the European storm petrel (*Hydrobates pelagicus*). The study was performed based on a grant G14, which I was leader of. Together with two colleagueas, we examined morphological differentiation of the global population of the European storm petrel (P39). We used biometric data collected on our own (Faroe Islands), and from literature (other locations). The paper P39 presents morphological variation of the target species at different scales (global population, and separately for subspecies), as well as discrimination function to tell the sex based on morphometric. Results of the study indicates on relationships between the birds body size and climate and weather conditions at the breeding colonies. The proposed function to discriminate between the sexes allows to establish the sex of 75% birds based on wing and total head lengths.

Finally, still being focused on the populations ecology issue, I have performed with colleagueas an ornithological survey of species occurring in Hornsund (Spitsbergen, Norway) (P9). In this study we compared current size of local populations of all bird species occurring in the area with the state from the past, known from literature. This comparison revealed some significant changes in abundance of some species (e.g. barnacle goose *Branta leucopsis* and pink-footed goose *Anser brachyrhynchus*). The study, presenting the current size of local populations of avian species constitutes a background for investigation of potential changes in the local avifauna in the future.

Abundance of microorganisms (including pathogens) in ecosystems, with special emphasis on the Arctic

Owing to various project carried out in the Arctic, I had possibility to investigate the issues associated with uniqueness of the Arctic ecosystem. The Arctic, indeed, combines specific habitats – due to severity of the climate, many group of organisms that are common in other zones do not occur in the Arctic. However, that pattern changes due to climate changes and human activity. Studying occurrence and abundance of various group of organism in the Arctic deliver not only the information about the organisms distribution, which are interesting *per se* but may also be a tool for controlling the changes in the Arctic ecosystem. I dealt with that issue in cooperation with specialists in ecology of various group organism. I investigated: a) occurrence of hemosporidian in the little auk in three different colonies on Svalbard (P17); b) occurrence of micro-fungi in throat and cloaca of the little auk (P31) oraz c), antibiotic resistance of bacteria occurring in faeces of the glaucous gull (P42). In the study P17, we

found no evidence of heamatozoa in the little auk, which indicates the Arctic ecosystem is still free of that kind of parasites. Examining the fungi assemblages in the little auk body (P31) we found 12 species of yeasts, with three being reported from birds for the first time ever. Although we have not observed any symptoms of fungi-origin disease in birds, all yeast species are potentially pathogenic, also for human. The results clearly indicate that pathogens are omnipresent, and occur even in relatively sterile Arctic environment. This was even more evident while examining antibiotic resistance of bacteria in P42, when we found resistant strains of bacteria. Interestingly, we found that a new mutation in AmpC beta-laktamase gene is responsible for this antibiotic resistance.

Finally, I examine with co-authors frequency of puffinosis occurrence and influence of the disease on haematological parameters in the European storm petrel, while working with the breeding and population ecology of the species (G14). Puffinosis is a disease of unknown etiology, with symptoms of feet degeneration. It has been reported from some *Procellariforemes,* including the European storm petrel. Results of the study were presented in the paper, that has just been accepted for publication in *Wilson Journal of Ornithology* (not included in the list in Appendix 3 due to still not yet known volume and pages numbers).

Additional issues – unsystematic observations

Doing various projects on the little auk I was lucky to observe some unusual behaviours (reverse male and female position during the copulation, homosexual copulations, P7) unusual phenomena (chromatic aberrations P25, doubled clutch size P14) and unknown hunting techniques of the main little auk predator, the glaucous gull (P15). Although all these observations were rather unsystematic, they were found to be interested for other researchers (e.g. P7 – cited in Poiani 2010, and MacFarlane et al. 2010). The paper P14 , about doubled brood size in the little auk, became an inspiration for a field experiment which I have performer with colleague three years later (P38). We tested in this study the hypothesis about possibility of raising larger brood in the little auk. Kozlova (1957) has proposed that given the wide brood patch in the little auk, it could had have brood size of two eggs in the past. We found in P38 that incubation of doubled size brood, although possible is not so efficient. Thus, the single-egg brood is probably evolutionary old trait of the little auk, possibly an adaptation to the Arctic conditions.

Ecophysiology, morphology and differential migration of passerines of reed bed habitat

Investigating various issues of breeding biology and ecology of the little auk, I got interested in general avian ecophysiology, particularly in influence of various intrinsic and extrinsic factors on birds body condition parameters. I examined with colleagueas that issues in small, reedbed passerines, using field station of Dept. of Vertebrate Ecology and Zoology, University of Gdańsk on Druzno lake (area of reed bed habitat) and being supported by grants G8 and funds of the Department. We found a significant influence of age, sex, phase of breeding and autumn migration on heamatological parameteres and body mass in the reed warbler (*Acrocphalus scirpaceus*) and sedge warbler (*A. schoenobenus*) (P33), as well as in the Reed bunting *Emberiza schoeniclus* (P21). In another study we found significant influence

of the hemoparasite infection on haematological parameters in the reed and segde warblers (P24). At present, another work of that series is in progress. In that study we deal with influence of birds moulting on the body condition in the Savi's warbler (*Locustella fluviatilis*). For two species, which we dealt with in the ecophysiological project, i.e. sedge warbler (P20), and Savi's warbler (P35), we also proposed a discrimination function that allows to tell the sex of birds based on morphometrics.

Owing to the fact that the study on reedbed passerines comprised also the period of autumn migration, I had also opportunity to deal the migration issue. I was particularly interested in differential migration of the sexes as this may be an important life-time strategy trait. Differential migration have been reported for some species, however most of the studies focused on the spring migration, and species with apparent sexual dimorphisms. We examined the issue in monomorphic, molecularly sexed reed and sedge warblers during autumn migration (P13). We found that significant sex differences in timing of migration at the Druzno stopover site in reed, but not sedge warbler. To check how common differential migration of the sexes is in the genus, we performed a separate study in another species of the genus, aquatic warbler (*Acrocphalus paludicola*) migrating through a stopover in W France (Loire estuary). We found differential migration pattern in the aquatic warbler, with adult males starting the migration before adult females and immatures of both sexes (P30). Since differential migration of aquatic warbler was examined in a single season and stopover site, I continue the project in 2013, expanding the sampling on 10 different stopover sites along the whole western cost of France. This project is carried out in cooperation with prof. Frédéric Jiguet (Natural History Museum in Paris, France). Investigating the aquatic warbler differential migration, we have also collected data about the birds body condition. Analysing this data we found that birds using fat reserves that they have at the studied stopover site (Loire estuary) are able to fly over a distance of ca 1000 km, so to reach the north Africa, but not yet wintering grounds.

Offspring sex ratio

Another scientific question which I am interested in is the offspring sex ratio. There is a growing scientific interests in this topic as more and more studies deliver evidence of offspring sex ratio changing in an adaptive way. Studying that issue with colleagueas in the great cormorant we found that the number of sons in the brood, which are more costly than daughters due to sex difference in body size, decreases with the progress of breeding season. This is probably related to trophic conditions that deteriorate with advanced of the season (P29). In another paper (P45), we showed that offspring sex ratio in the cormorant broods changes in the gradient from the colony centre to peripheries, with more sons being raised in the colony centre (P45). The pattern is likely to be linked with differentiated distribution of birds of better and worse quality, with the former occupying the central place in the colony, the most safe from predators. This is the first time, when the offspring sex ratio was considered in the spatial scale, so the paper should inspire other researchers who wish to investigate how universal is the pattern observed.

Literature

Appendix 2

-- own papers cited in the text body are given with the list of all publications in Appendix 3

-- others:

Gabrielsen G.W., Taylor J.R.E., Konarzewski M., Mehlum F. 1991. Field and laboratory metabolism and thermoregulation in Dovekies (*Alle alle*). The Auk 108: 71-78.

Harding A.M.A., Pelt T.I.V., Lifjeld J.T., Mehlum F. 2004. Sex differences in Little Auk *Alle alle* parental care: transition from biparental to parental-only care. Ibis 146: 642-651.

Hupton G., Portocarrero S., Newman M., Westneat D.F. 2003. Bacteria in the reproductive tracts of red-winged blackbirds. *Condor* 105: 53–464.

Kozlova E.V. 1957. Charadriiformes, suborder Alcae. In Fauna of USSR: birds. Vol. 2, No. 3. Zoological Institute of the Academy of Sciences of the USSR, Moscow,Leningrad

Lombardo M.P. , Thorpe P.A. 2000. Microbes in tree swallow semen. Journal of Wildlife Disease 36: 460–468.

Maynard Smith J. 1977. Parental investment – a prospective analysis. Animal Behaviour 25: 1-9.

MacFarlane G. R, Blomberg S.P., Vasey P. L. 2010. Homosexual behaviour in birds: frequency of expression is related to parental care disparity between the sexes. Animal Behaviour 80: 375-390.

Petrie M., Kempenaers B. 1998. Extra-pair paternity in birds: Explaining variation between species and populations. Trends in Ecology and Evolution 13: 52-57.

Poiani A. 2010. Animal Homosexuality: A Biosocial Perspective, Cambridge University Press

Schreiber E.A., Burger J. 2001. Biology of Marine Birds. Marine Biology Series, CRC.

Stempniewicz L. 2001. Little Auk *Alle alle*. BWP Update. – Journal of Birds of Western Palearctic 3: 45-201.

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